AGS Studies with Gold

matching, coupling, and stripping

APEX workshop 13Nov09

ahrens

Gold beam studies: what and why?

The AGS machine/model understanding effort is driven by polarized protons needs. Gold provides a simpler (no snakes) machine setup and stronger signals (because of the z^2 in the electromagnetic response) from some diagnostics – the BtA multiwires (and A15MW in AGS) and the AGS IPM – for injection matching studies. Also the lower injection rigidity means it is easier to remove beam at injection with a dipole kick - to see effect of only a couple of turns on the A15MW.

Effort 1: Goal: to optically match from Booster into the AGS and to be able to prove that this has been done. Tool development, but also good for gold.

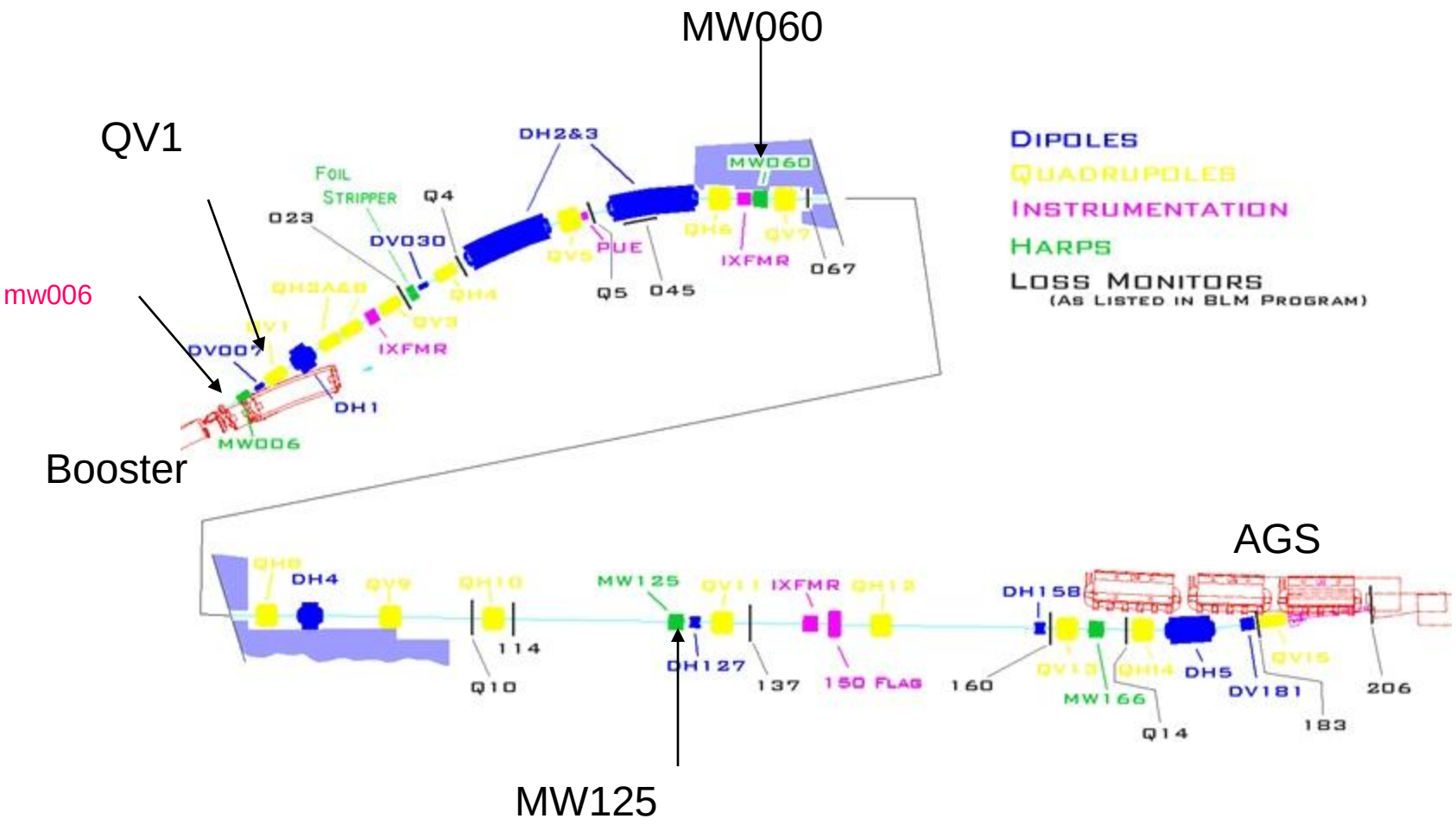
We may need to move the machine setup away from what is optimized for RHIC injection (a different AGS User) and so may also need a different BtA setup => this would then require dedicated time.

Necessary to know BtA. The substantial study work (see K. Brown et al. PAC09 paper) carried out in October ’08 left us with better consistency among the many BtA measurements and the model (what exactly? – some model evolutions and improved knowledge of the currents in the BtA quadrupoles …).

A15 multiwire response potentially gives the most reliable check on matching. Possibly also IPM, though historically IPM not impressed by mismatching especially with gold.

So I take us on a minor digression into a tiny fraction of the BtA work.

the BtA transfer line (between Booster and AGS) primary instrumentation: four multiwires.



From the BtA study one year ago: a “typical” quad scan:

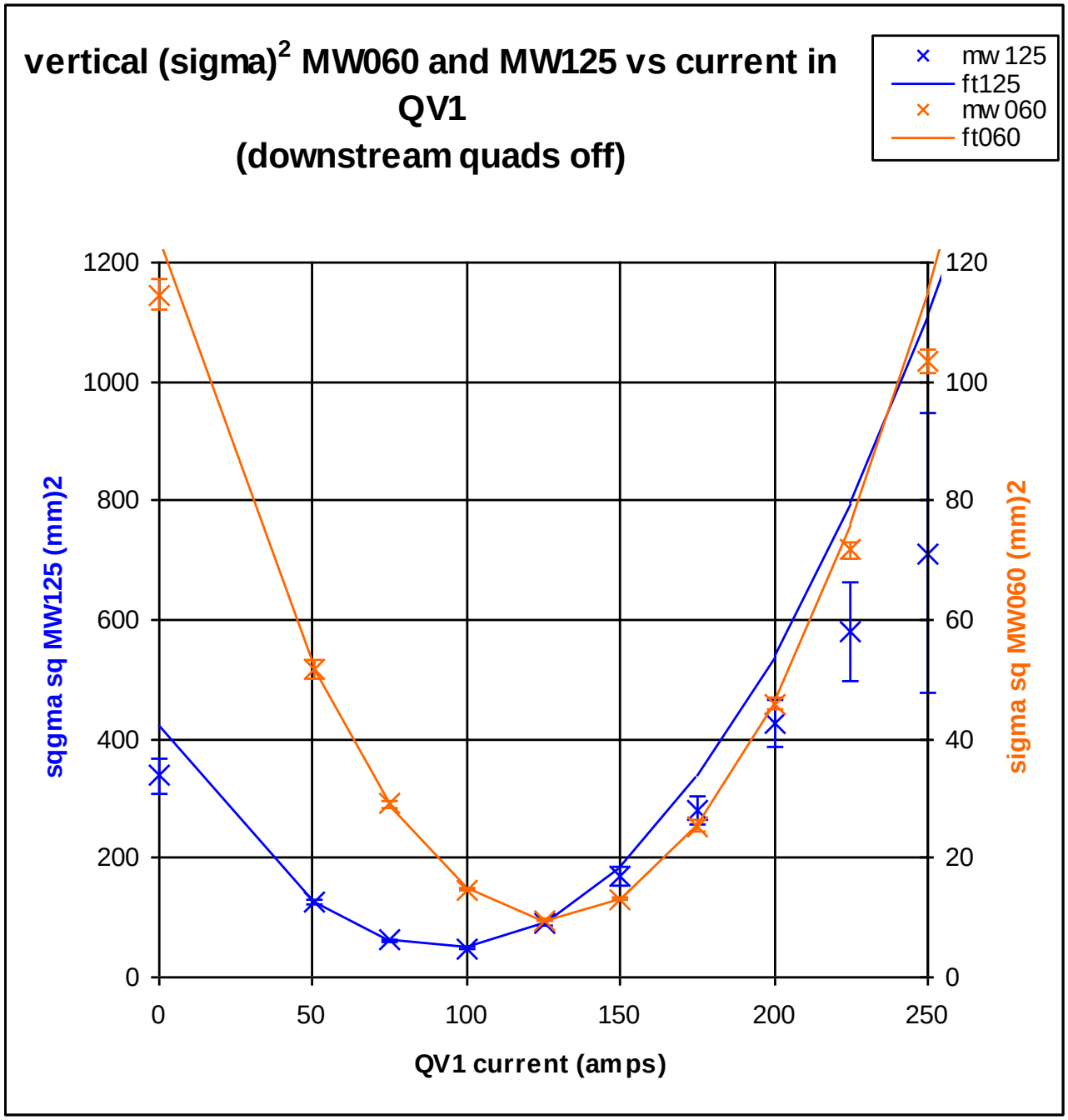
Scan (K. Zeno) of the first quad in BtA (physically located near MW006) and measuring the beam sizes at MW060 and MW125 (with the intervening quads off !).

From this derive vertical beta function at QV1:

(mw060: 18.9 +/_ (?) m)
(mw125: 21m

model says (20.7m). So expect that beta predicted by model just upstream at MW006 is ok.

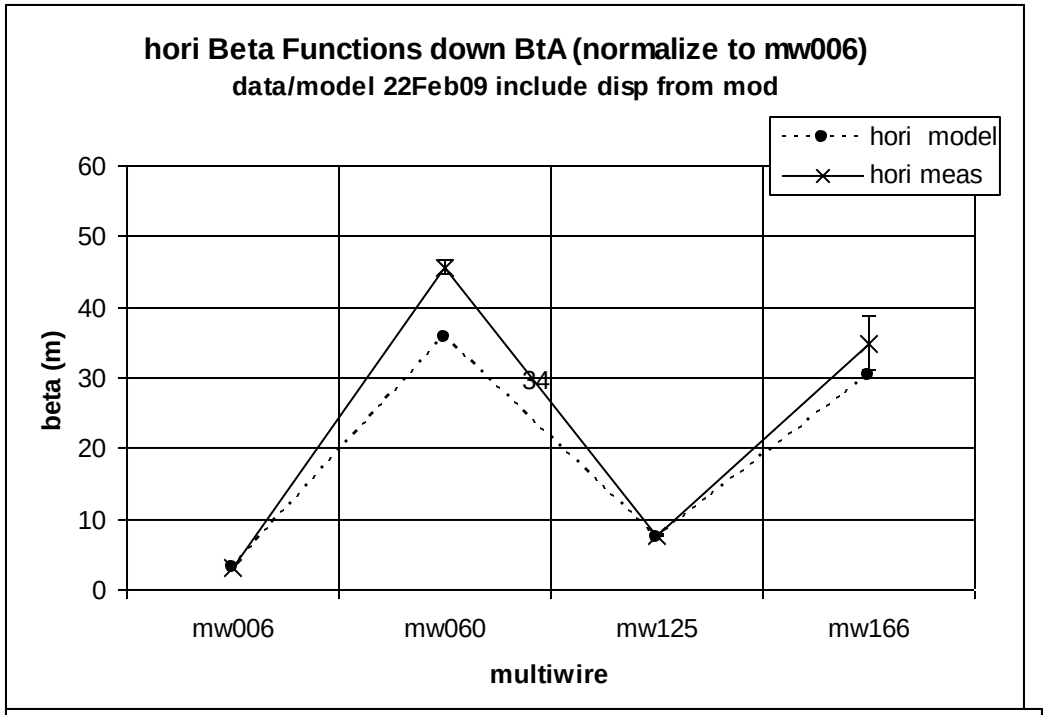
Leverage this near agreement to make comparisons of (model/measurement) at other multiwires.

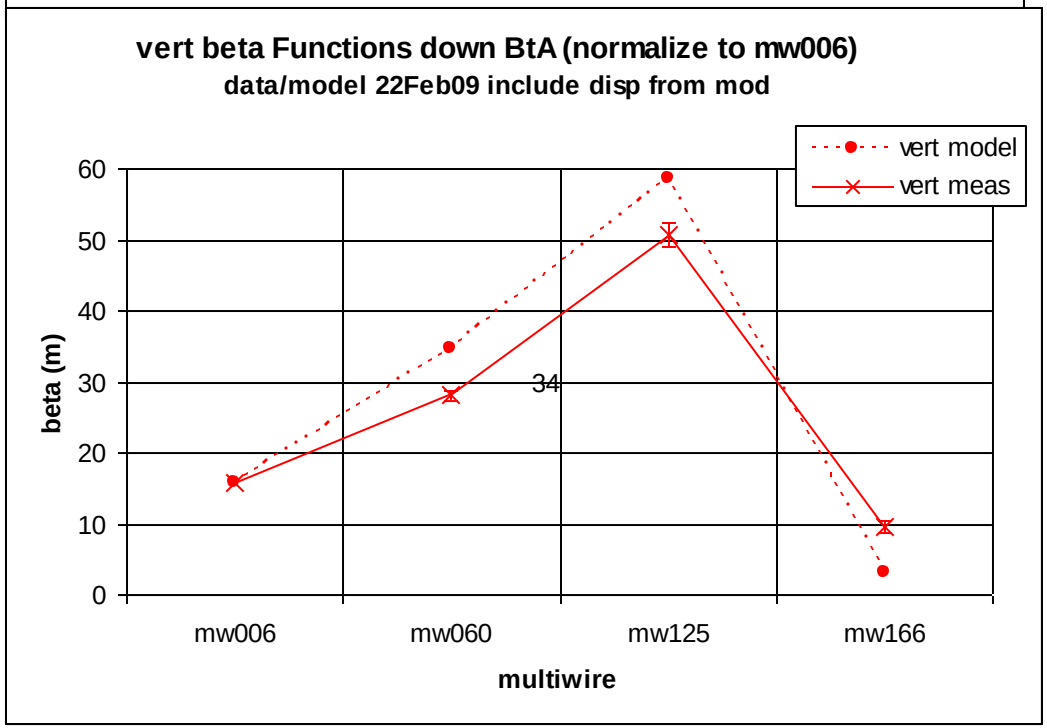


(Results from the Oct 08 BtA study (cont):

Predicted/measured beta function ratios along the BtA transfer line. Using measured beam widths at the multiwires, “known” beta function at MW006, and assumption that emittance is constant to predict betas.

This data was taken this Feb 09 (long after the study) – good agreement, much better than measurements before/during the study sessions.





Conclusions:

The behavior of the BtA diagnostics is encouraging. Putting the observations together into a coherent picture of the quality of the (model/machine) match is very hard. However, if we can demonstrate an optical match into the AGS, this will be enough. The gold AGS machine (no snakes) is a good place to try.

Effort 2: a second activity and associated goal: to quantify the transverse coupling in AGS, fitting the turn-by-turn response from the tune meter pickups to coupled oscillations and extracting quantitative coupling strength parameters.

Players: Kip Gardner, Vincent Schoefer, Dave Maffei.

Again the motivation is getting a better understanding of the AGS and moving that understanding into the model. Working with the gold machine allows a simpler (than the polarized snakes machine) situation, though not trivial. The “bare” AGS exhibits a significant coupling which we may be able to better quantify and model ... and even explain perhaps.

Whether what we will learn helps the polarized effort is an open question, though I think we would all agree that any improved confidence in the model is valuable.

Status: 1) AGS tune meter coupling analysis looks promising though not yet “automatic”. 2) The model (MADX) gives “consistent” answers for the effect of the AGS skew quads – consistent with analytic calculation and the model-reported “strength” ~ what is seen - old data, preliminary - with the skew quads. The cleanest measurements are yet to be made hence the study.

Doing a little data mining to exercise a prototype of the new tool:

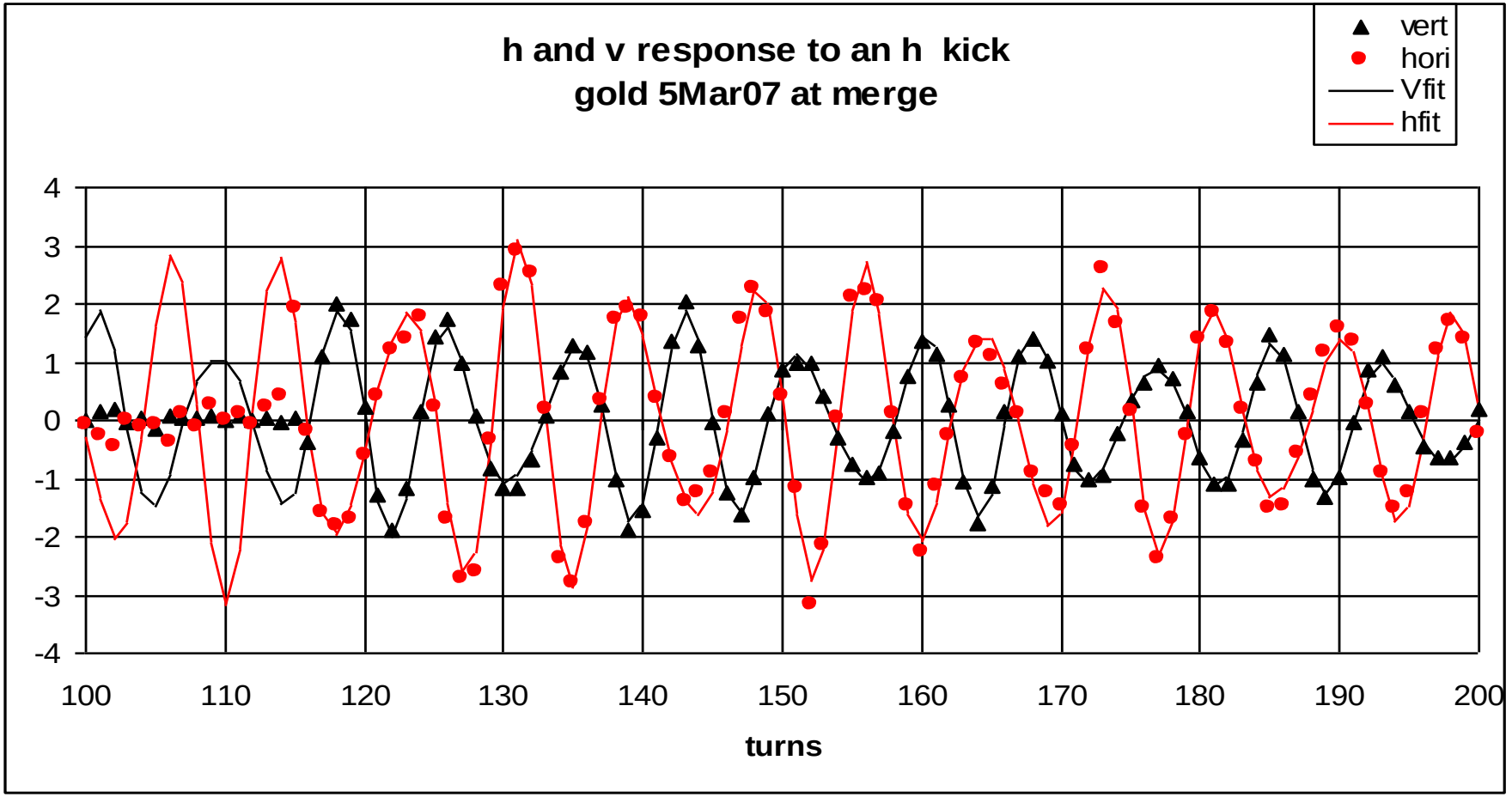
First back to a tune measurement taken at AGS gold injection at the beginning of the 2007 Gold run.

For this data, there was not yet any coupling correction applied.

The turn-by-turn response of vertical and horizontal beam position monitors is fitted to sine waves – projections of the normal modes - whose frequencies and amplitudes give quantitative information about the coupling strength.

Following one of Kip's suggestions to get a metric: One measure of coupling "strength" K^2 = -|**m**+ **n**bar| determinant of this combination of off diagonal 2x2 blocks in 1 turn 4x4 matrix (**n**bar is symplectic conjugate of **n**). Both the beam measurement and the model can provide this number for a given machine setup.

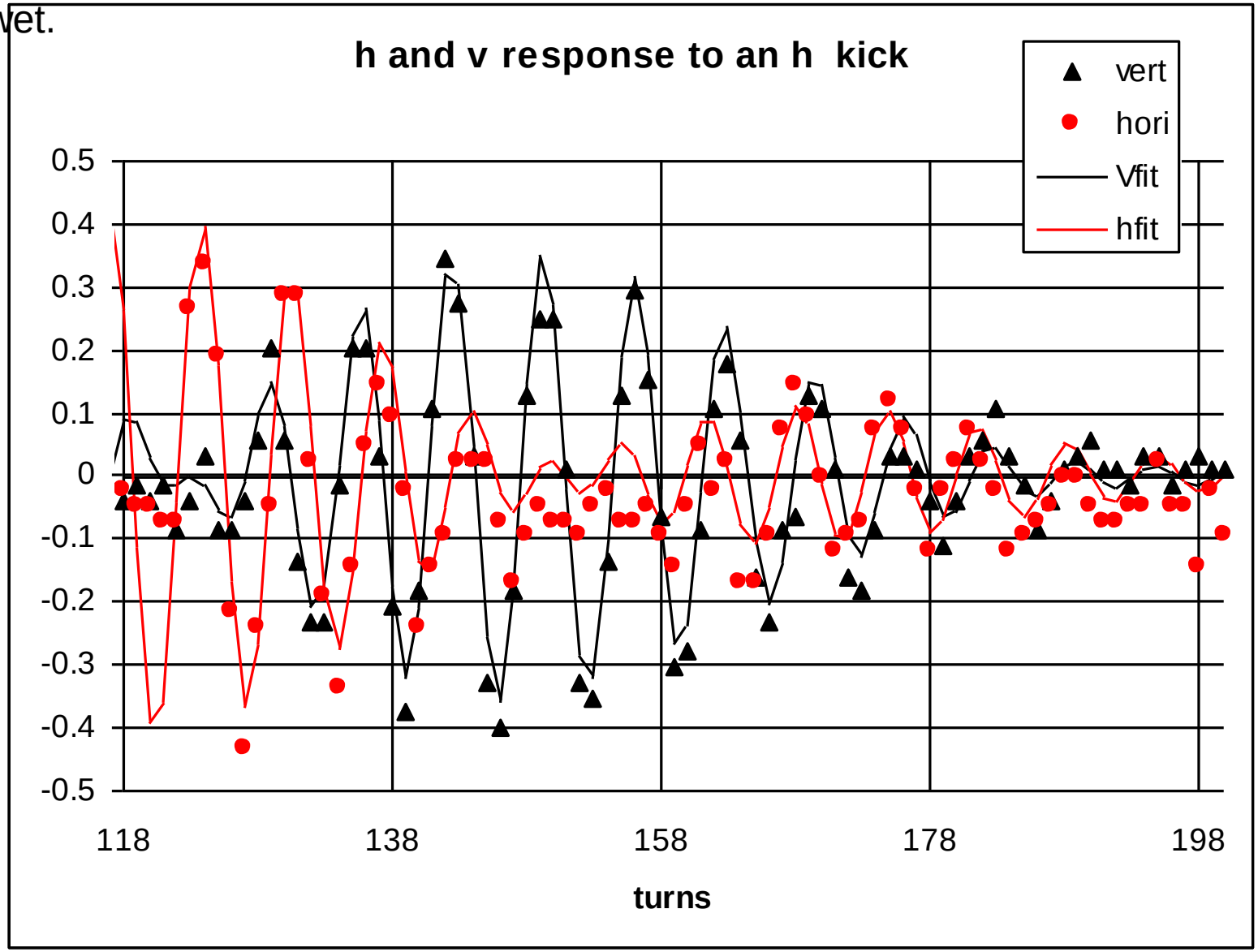
5Mar07 gold during setup. Measured “strength” K = 0.22. This extracted from fitted amplitudes of the captured in the two pue planes.



Here calculated K = 0.22.

MAD test (Vincent): For standard 6 AGS skew quad string at the normal 7A at proton injection, MADX (and also ~ analytic calculation) give K = 0.16. Encouraging that these are about the same size as beam-measured effect.

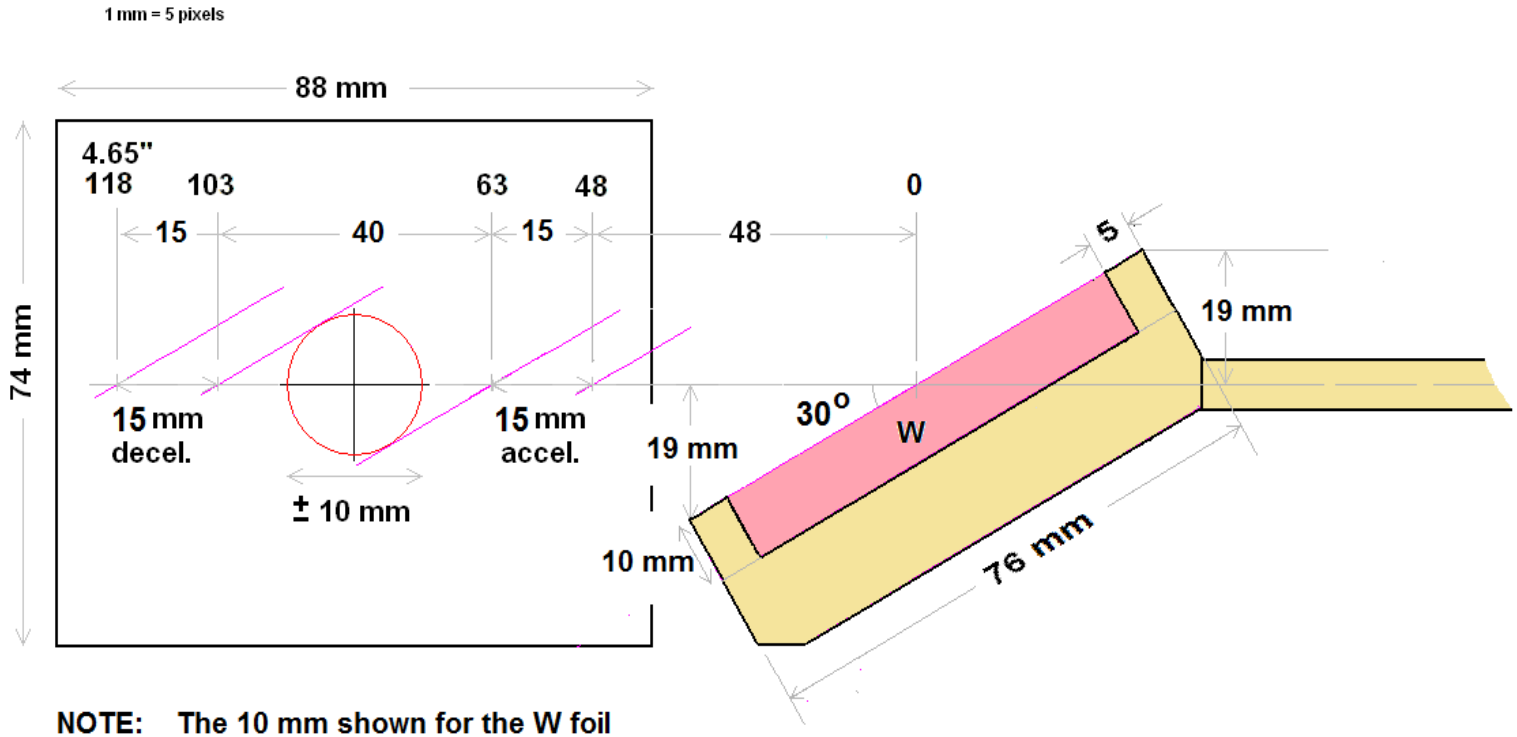
25may09_143103 protons. Just another sample, this from protons and with both the CSNK and the skew quads powered nominally. The strength here is calculated to be K=0.07, so much weaker by this measure– but we are just getting our feet wet.



Finally to the third topic:

The matching and coupling investigations are studies. We have some commissioning efforts to carry out as well, including the use of the new J7 “plunging-stripping foil”, which is intended to clean up the internal dumping of the Au77+ beam. This at worst will be a study of the behavior of material (tungsten) under extreme conditions (very fast, very localized heating).

This is a drawing (Peter Thieberger) of the plunging foil. The foil will plunge through the beam (~ ms) just before normal dumping, stripping the two electrons and so causing the stripped particles to veer more strongly into the J10 dump absorber. (major players: Kip, Peter, George Mahler, and Dave Gassner. (Dave is champion for the jumping mechanism.)



NOTE: The 10 mm shown for the W foil width is the proyection. This foil will be bent out of the plain of the drawing by ~25 degrees and its actual width should be 11 mm.